# DRAFT TECHNICAL MEMORANDUM 5-11

**Date:** MAY 15, 2020
**Project:** Phase 2 Raw Water Delivery System
**To:** BCRUA Design Oversight Committee
**From:** WP/FNI JV | Kevin St. Jacques, P.E., PTOE

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## TRAFFIC IMPACTS OF CONSTRUCTION ACTIVITIES

### 1.0 PURPOSE OF THE TRAFFIC IMPACT ASSESSMENT

Brushy Creek Regional Utility Authority (BCRUA) is a partnership of the cities of Cedar Park, Round Rock, and Leander. The Phase 2 Raw Water Delivery System Project (Project) is a new deep-water intake, Pump Station, and conveyance system to access deep water in Lake Travis for delivery to three water treatment plants (WTPs). The vehicles required for the construction of this facility will exceed the volume and types typically carried by these roadways. This study focuses on traffic impacts associated with key elements of construction of the Project, including:

1. The anticipated trucking activity required to haul excavated materials, daily construction operations and the resulting impacts on traffic operations on Lime Creek Road, FM 2769 and on the local access streets (Jackson Street et al.) to the Maintenance Building.

2. Limitations posed by the curvature and terrain along Lime Creek Road on the trucking of excavated materials, construction equipment and machinery, building materials and pump equipment.

3. Traffic and Parking for personnel involved with construction activities.

#### *1.1 Project Description*

The purpose of the Project is to provide a reliable water source in Lake Travis capable of supplying 145 million gallons per day (MGD) to the BCRUA Regional, Cedar Park and Leander Sandy Creek Water Treatment Plants. The anticipated facilities to be constructed include the following:

- Raw Water Intake – Two lake taps and riser pipes with multi-level screens connecting to a 96-inch diameter gravity tunnel located in Lake Travis southwest of Bernard Street in the Village of Volente, Texas.
- Gravity Intake Tunnel - 9,000 linear-foot (LF) tunnel conveying water from the intake to a remotely located pump station by gravity. Construction of the tunnel liner may require drop shafts at two locations on Lime Creek Road for concrete delivery.

- Pump Station – 145 MGD capacity pump station, building and 300-foot deep shaft/wet well connecting to a suction chamber.
- Intake Maintenance Facilities – On shore Maintenance Building located adjacent to the intake on a 5.2-acre site that will house chemical feed systems for invasive mussel control.
- Pressure Transmission Tunnel - 2,600 LF tunnel with welded steel liner conveying water from Pump Station to the existing raw water line on Trails End Road.

### *1.2 Study Location*

The BCRUA Pump Station and Maintenance Building are in Travis County on the east side of Lake Travis. Vehicle access to the Pump Station location is directly from Lime Creek Road, while the Maintenance Building is located farther south of the Pump Station along Lime Creek Road, then along Jackson Street to its end at Bernard Street. Lime Creek Road turns into FM 2769 southeast of the Maintenance Building site in the Village of Volente. This report studies the entire 8.8-mile length of Lime Creek Road and 6.3-mile length of FM 2769 within the Cities of Austin, Cedar Park and Volente as shown in Figure 1, as well as the 2,500-foot length of Jackson Street. Lime Creek Road is a two-lane roadway that passes along the edges of the hilly terrain. There are many curves and inclines along the roadway that will affect the operation of trucks along its length. The segment of Lime Creek Road north of the Pump Station site is less developed than the Lime Creek and FM 2769 segments to the south.

For detailed assessment, the roadway is divided into three study segments, as shown in Figure 1:

- Segment 1 - Lime Creek Road North of Pump Station Site,
- Segment 2 - Lime Creek Road between Pump Station and Maintenance Building Sites, and
- Segments 3 – 5 - Lime Creek Road & FM 2769 Southeast of the Maintenance Building Site.

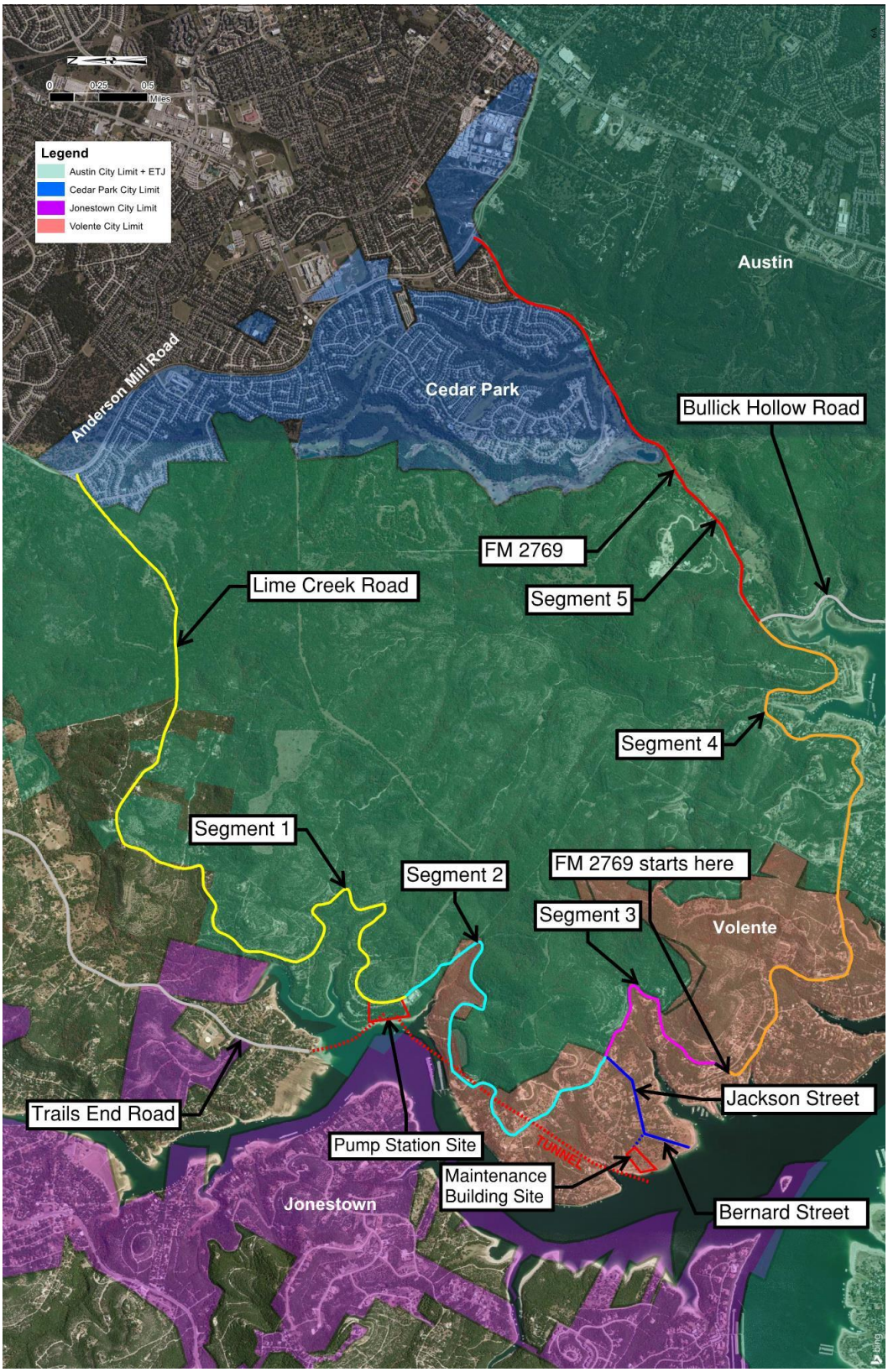


*Figure 1. Study Location Showing Pump Station and Maintenance Building along Lime Creek Road*

## 2.0 EXISTING CONDITIONS

Construction activities can be expected to impact traffic operations and pavement conditions along the haul routes for construction activities. An assessment is made of the current traffic and geometric conditions along the roadway as well as existing adjacent land uses along the anticipated haul routes for construction.

### *2.1 Existing Roadway Configuration*

#### 2.1.1 Lime Creek Road North of Pump Station Site (Segment 1)

Lime Creek Road is accessed by local residents and recreational visitors to the Sandy Creek Park. It provides access to Sandy Creek Park just west of the Pump Station site. Lime Creek Road has a few driveways to low-density residential sites along its length. Residential subdivisions of Cedar Park have local street access to Lime Creek Road approximately 1,000 feet west of Anderson Mill Road.

Lime Creek Road is approximately 5 miles long from Anderson Mill Road to the BCRUA Pump Station. The road section is two lanes approximately 21’ wide with one lane in each direction and limited dirt/gravel shoulders (1’-4’ wide). This typical section is shown in Figure 2.

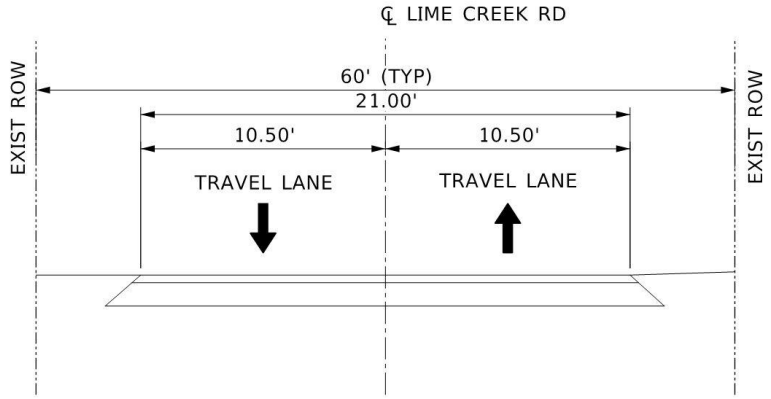


*Figure 2. Existing Typical Section*

The posted speed limit is 40 MPH with multiple curves requiring speed reduction. The advisable speed reduces to 15 MPH to 20 MPH along Lime Creek Road at three locations of severe roadway horizontal curvature (discussed in greater detail in Section 4.0 of this memo). The grades along Lime Creek Road slope gradually (3 to 5% grade) downhill from north to south. Going downhill, heavy trucks will need to control their speed, particularly the mid-point section between Anderson Mill Road and the Pump Station. Going uphill, trucks can lose momentum, especially fully loaded or if slowing for traffic conditions, and eventually be on a long slow climb along Lime Creek Road. School buses have been observed to operate along Lime Creek Road.

The roadway section changes approximately 500 feet west of Anderson Mill Road to provide one additional lane for left turns at the stop line for the intersection. A traffic signal is provided at the intersection with Anderson Mill Road, which is a four-lane divided roadway with posted speed limit of 45 MPH. Travis County maintains this segment of Lime Creek.

### 2.1.2 Lime Creek Road between Pump Station and Maintenance Building Sites (Segment 2)

The 2.5-mile segment of Lime Creek Road between the BCRUA Pump Station site and the access street to the BCRUA Maintenance Building site is approximately 21 feet wide with 2 lanes – one lane in each direction - and dirt shoulders of 1 to 4 feet in width, as shown in Figure 2. The posted speed limit is 40 MPH with warning signs posted at one 15 MPH curve. The roadway segment lies within the Village of Volente. This segment of Lime Creek Road provides access to Sandy Creek Marina and sparsely developed residential home sites, some with driveways directly onto Lime Creek Road.

### 2.1.3 Lime Creek Road Southeast of Maintenance Building to FM 2769 (Segment 3)

The 1.2-mile segment of Lime Creek Road between the BCRUA Maintenance Building site southward through the Village of Volente to the all-way stop at the beginning of FM 2769 is approximately 21 feet wide with 2 lanes – one lane in each direction - and dirt/grass shoulders of 2 to 4 feet in width, , as shown in Figure 2. The posted speed limit is 40 MPH with warning signs posted at one 15 MPH curve. This segment passes through the center of the Village of Volente and its many driveways, and with an all-way stop at Warf Cove, where Lime Creek Road turns into FM 2769.

### 2.1.4 FM 2769 from Lime Creek Road to Bullick Hollow Road (Segment4)

The 3.75-mile segment of FM 2769 between the center of the Village of Volente and through the City of Austin ETJ to Bullick Hollow Road is approximately 21 feet wide with 2 lanes – one lane in each direction - and paved shoulders of 1 to 2 feet with dirt/grass shoulders beyond measuring 1 to 4 feet in width, as shown in Figure 2. The posted speed limit is 35 MPH, with many curves, several with warning signs posted at 30 MPH, 25 MPH and 20 MPH but none at 15 MPH, and with hilly terrain. The land uses adjacent to FM 2769, between the center of the Village of Volente and Bullick Hollow Road, range from small commercial in the Village of Volente to sparse residential in the City of Austin ETJ.

### 2.1.5 FM 2769 Bullick Hollow Road to Anderson Mill Road (Segment5)

The 2.55-mile segment of FM 2769 between Bullick Hollow Road to Anderson Mill Road is approximately 21 feet wide with 2 lanes – one lane in each direction - and paved shoulders of 0 to 2 feet with dirt/grass shoulders beyond measuring 1 to 4 feet in width, as shown in Figure 2, though a 1,000-foot section has guardrails at the edge of the travel lanes on each side and no shoulder. The posted speed limit is 45 MPH, but with several curves posted for 30 MPH, and moderate slope. The land uses adjacent to FM 2769, between Bullick Hollow Road and Anderson Mill Road, range from sparse residential in the City of Austin ETJ to the residential subdivisions within Cedar Park developed within approximately 1.0 mile west of Anderson Mill Road. FM 2769 remains as two lanes, even with this increase in density of uses, with less than 3 feet of paved shoulder until about 250 feet west of the approach to the Anderson Mill Road intersection, at which point an auxiliary lane is added to provide a left turn lane and a right turn lane at the intersection. A traffic signal is provided at the intersection with Anderson Mill Road, which is a four-lane divided roadway with posted speed limit of 45 MPH.

### 2.1.6 Jackson Street and Sherman Street between Lime Creek Road and the Maintenance Building

Two local street routes to the Maintenance Building are possible – Jackson Street and Sherman Street as depicted in Figure 3. The attributes of these two options are summarized in Table 1.

*Table 1. Maintenance Building Access Options – Jackson Street or Sherman Street.*

| Attributes | Option 1- Jackson Street | Option 2 - Sherman Street |
|---|---|---|
| Intersection at Lime Creek Rd | Intersection on tangent | At 300 feet from curve, Line of sight to north limited |
| Development along Street | Houses 200+ ft set back<br>Mailboxes at edge of street | Houses 100+ ft set back<br>Mailboxes at edge of street |
| Width of Street Pavement | 16 to 18 ft asphalt with<br>1 to 4 ft dirt shoulders | 16 to 18 ft asphalt with<br>1 to 4 ft dirt shoulders |
| Type of Improvement | 100 LF of roadway improvements on Jackson St to align with Bernard St extension. (See Figure 10.) | Corner revisions to intersection of Sherman St. and Bernard St. allowing truck turning movements. This would require ROW purchase. |
| Improvements along Bernard Street | 700 LF | 250 LF |

The comparative merits of the Jackson and Sherman Street approaches to the Maintenance Building are discussed in further detail in section 4.5 of this memo.

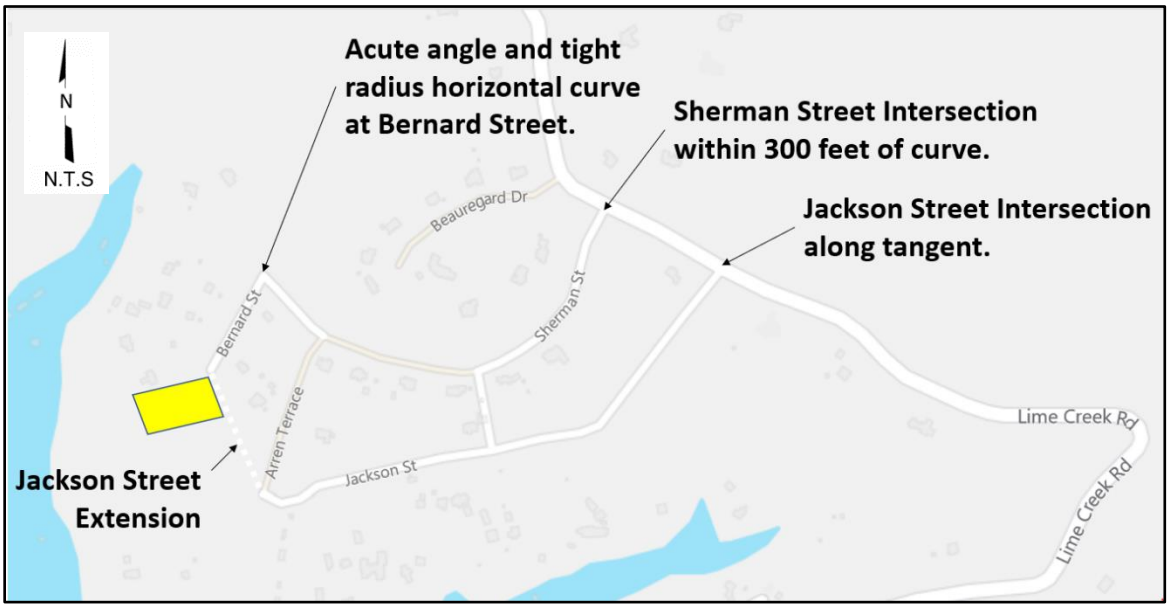


*Figure 3. Jackson Street Near Maintenance Building*

## 2.2 Land Uses Along the Haul Route

The land uses along the Lime Creek Road haul route vary from residential near Anderson Mill Road to low density residential plus water access at marinas. A portion of the roadway is also bordered by nature preserves both north and south of the Pump Station site.

#### 2.2.1 City of Cedar Park Land Uses

The City of Cedar Park extends along the length of Anderson Mill Road between the two intersections of Lime Creek Road. The urban-style subdivisions of Cedar Park extend along the southern segment of Lime Creek Road for approximately one mile, but with street access onto Lime Creek Road provided at only three locations. Two of these side streets, Dies Ranch Road and Abbotsbury Drive, connect through the subdivision to signalized intersections on Anderson Mill Road.

#### 2.2.2 City of Austin Land Uses

Within the City of Austin and its ETJ, which lies along both the northern and southern segments of Lime Creek Road, land uses are predominantly single-family homes on one-acre or larger lots. Many residences have driveway access directly onto Lime Creek Road. Cypress Creek Marina is accessed from the southern section of Lime Creek Road between the City of Cedar Park and Village of Volente.

#### 2.2.3 Village of Volente Land Uses

The Village of Volente is situated along the lakefront edges of Lime Creek Road. Land uses in the village are predominantly single-family homes on one-acre or larger lots. Many residences have lakefront access and most of these lots are accessed from numerous side streets that feed onto Lime Creek Road. In addition, many residences have driveway access directly onto Lime Creek Road. Some recreational development exists near the center of the Village of Volente serving the Volente Beach Resort and Waterpark, Highland Lakes Marina, and Nautical Boat Club-Volente. Sandy Creek Marina is at the northern end of the Village of Volente along Lime Creek Road midway between the BCRUA Pump Station and Maintenance Building sites.

## 3.0 ANTICIPATED CONSTRUCTION TRUCK TRAFFIC

Heavy equipment will be required for the construction of the Pump Station to perform the required excavation and construction of the tunnel and Pump Station including concrete trucks, delivery trucks, large cranes, and excavation equipment. The Maintenance Building will require similar construction vehicles at a smaller scale. Equipment and materials will be delivered by trucks including semi-trucks (tractor-trailer type). The large amount of spoils excavation required for construction of the Pump Station will require removal by either dump truck or tractor trailer. Construction traffic to be considered for this project include daily truck traffic and deliveries of equipment and materials.

### *3.1 Hauling of Excavated Material from Tunneling*

In Technical Memorandum 5-4: Spoils Management Plan (TM 5-4 dated April 23, 2020), an assessment was made of the amount of excavated material that would be generated from the drilled lake taps at the raw water intake, for the 9,000-foot long (96-inch diameter carrier pipe) gravity intake tunnel, the 300-foot deep wet well and subterranean suction chamber at the Pump Station and 2,600-foot (78-inch diameter carrier pipe) tunnel connecting the Pump Station to the existing Phase 1 raw water pipe. That technical memorandum provides information on spoils characterization, spoil volume estimates, testing considerations, spoils hauling, and disposal location alternatives.

As shown in Table 2 (source: Table 2 of TM 5-4), the estimated total loose volume of excavated materials (spoils) is approximately 108,140 cubic yards (CY). These volumes of excavated materials include a bulking factor of 30% to 65%, depending on type of material, for the growth of volume of the materials once excavated from their original condition. The spoils will be predominantly granular rock, gravel and cobble size particles depending on the excavation method used. Notably, the Pump Station shaft and its tunnels generate about 98% of the total spoils with the Maintenance Building accounting for about 2% of the total.

The haul routes for the spoils from construction of the Pump Station site and from the Maintenance Building site are discussed in TM 5-4, Spoils Management Plan.

*Table 2. Estimated Loose Excavation Materials Volumes*

| Project Component | Excavation Method | Assumed Bulking Factor | Loose Volume (Cubic Yards) |
|---|---|---|---|
| Intake Tunnel | TBM Tunneling | 65% | 61,730 |
| Transmission Tunnel | TBM/Road Header Tunneling | 65% | 14,200 |
| Transmission Pipeline (open cut) | General Surface Excavation | 30% | 2,330 |
| Pump Station Main Shaft | Drill & Blast or Road Header Excavation | 65% | 19,600 |
| Pump Station Vertical Discharge Shaft | Raise Bore Shaft | 65% | 2,950 |
| Pump Station Vertical Pump Shaft | Raise Bore Shaft | 65% | 4,940 |
| Pump Station Building Excavation | General Surface Excavation | 30% | 7,150 |
| Pump Station Suction & Temporary Chambers | Drill & Blast and Road Header Excavation | 65% | 4,970 |
| Pump Station Raw Water Supply Line to WTP | General Surface Excavation | 30% | 220 |
| **TOTAL Pump Station Site** | | | **118,090** |
| Upper/Lower Intake Shaft | Raise Bore Shaft | 70% | 730 |
| Maintenance Building Chemical Feed Line | General Surface Excavation | 30% | 780 |
| Maintenance Building Excavation | General Surface Excavation | 30% | 340 |
| Additional Drop Shafts for CIP Concrete Delivery | Blind Bore Shaft | 70% | 30 |
| **TOTAL Maintenance Building Site** | | | **1,880** |

### *3.2 Truck Trip Estimates During Excavation*

It is anticipated that space to store excavated materials on the Pump Station site will be limited. Therefore, for traffic planning purposes, it was assumed that the day's excavation would be removed from the project site over the course of each day. The rate at which spoils will be generated and need to be removed will depend on the contractor's methods of construction. In comparison with a similar project, the Jollyville Tunnel project bored a 12-foot diameter tunnel through similar rock formation, with a reported average daily rate of tunneling of 60 feet per day on a typical good day.

Using that comparable rate and a 65% bulking factor, the average daily rate of tunneling would produce about 528 cubic yards of spoils per day, with some days producing higher but mostly lower spoil quantities. For planning purposes, it is assumed that an average of 500 CY of spoils will need to be removed from the Pump Station site each day. Spoils production is not uniform and there are likely to be some accumulation of spoils that would be held on site during better tunneling days and would be removed using a few extra trucks on such days. Also, to optimize utilization of expensive machinery, it is not uncommon to mine 6 days a week with 1 day for maintenance. Work usually occurs in multiple shifts (day and night), so hauling of spoils may be busiest first thing in the morning. Any limitation on the days of week for hauling would concentrate hauling activities on the next hauling day. The duration of the excavation and removal of spoils is estimated to be 12 months.

Daily removal of an average of 500 CY of spoils can be accomplished using various truck sizes, examples of which are shown in Table 3. The size of truck used may be constrained by access and circulation on the site and the geometrics of the haul route. The trucks would be empty inbound to the site and loaded outbound.

*Table 3. Example Truck Requirements to Haul 500 CY of Spoils per Day (10-hour day)*

| Vehicle Type | Truck Capacity | Max. Weight | No. of Axles | Wheel Base | Truck Length | Average Trucks Required | |
|---|---|---|---|---|---|---|---|
| | | | | | | Daily | Hourly |
| SU 25 Dump Truck | 15 CY | 54,000 | 3 | 25 feet | 30 feet | 34 trucks | 4 trucks |
| WB 40 Dump Truck | 25 CY | 80,000 | 5 | 40 feet | 48 feet | 20 trucks | 2 trucks |
| WB 50 Dump Truck | 30 CY | 90,000 | 5 | 50 feet | 55 feet | 17 trucks | 2 trucks |

### *3.3 Truck Trips During Daily Construction*

In addition to the hauling of excavation spoils, there will be other hauling activities throughout the duration of the project to bring in building materials and equipment. The heavy truck daily activity would vary depending on site activities, with the 36 months of drilling operations seeing just a few heavy truck deliveries per day for piping and casings and concrete. The Maintenance Building construction would be accomplished during the tunneling operations. The 18 months of construction of the pump station would see many more heavy truck deliveries of materials and equipment. For planning purposes, it is estimated that there would be an average of 2 heavy truck deliveries per day during drilling operations (1 per day for the Maintenance Building site) and 10 heavy trucks per day during construction of the Pump Station site with an average of 4 axles per vehicle. Typically, the trucks would be loaded inbound to the site and lightly loaded outbound. It is also estimated that there will be and average of 10 medium size trucks per day traveling to and from the Pump Station site (2 per day for the Maintenance Building site) for general servicing of the construction site activities. There will be oversized (length and/or width) heavy truck deliveries of the various parts of the tunnel boring machine (TBM) and large and small cranes, large process tanks and structural beams as described later in Table 6. For planning purposes, it is estimated that there would be 40 such oversize truck trips, in and out, near the beginning and again near the end of the project.

## 4.0 CONSTRUCTION VEHICLE SIZE CONSTRAINTS

Lime Creek Road contains sharp curves, which will constrain the size of construction vehicle which can traverse its length. Five critical sharp curves, identified in Figure 4, are anticipated to present the most difficult maneuvers for heavy vehicles to access the construction sites. Curves 1, 2 and 3 lie between the Pump Station and Anderson Mill Road to the north. Curve 4 lies between the Pump Station and the Maintenance Building site and would be traversed by construction traffic if the Contractor elected to access the Maintenance Building site to and from the north along Lime Creek Road. Curve 5 would need to be negotiated if the Contractor elected to access the Maintenance Building site to and from the south and east along Lime Creek Road and FM 2769. Both Curves 4 and 5 would need to be negotiated if the Contractor elected to access the Pump Station site to and from the south and east along Lime Creek Road and FM 2769.


*Figure 4. Critical Movement Curves along Lime Creek Road*

*4.1 Design Vehicles*

*Figure 5. Small Dump Truck able to keep in lane along Lime Creek Road*

Field observations were made of a medium-size single unit 3-axle dump truck, (see Figure 5) estimated to be a 15 CY capacity truck with a 25-foot wheel base, that was traversing northbound along the northern segment of Lime Creek Road north of the Pump Station site. The single unit dump truck was readily able to traverse the 15 MPH curves while staying in its lane. Thus, the 15 CY single unit dump truck, with a wheelbase of about 25 feet (SU 25), was considered as a truck that could traverse Lime Creek Road, in both directions, unimpeded by the curvature of the roadway. A slightly larger SU 30 is also expected to be able to stay within its travel lane through the sharp curves. As a comparison, various size vehicles and their turning performance are shown in Table 4.

*Table 4. Turning Radius of Various Vehicle Sizes (source: 2001 Green Book and NCHRP Report 505)*

| Design Vehicle Type | Symbol | Minimum Design Turning Radius (ft) | Overall Length (ft) |
|---|---|---|---|
| Single Unit Truck | SU 25 | 42.0 | 30.0 |
| Single Unit Truck (three-axle) | SU 30 | 51.5 | 39.5 |
| Conventional School Bus (65 pass.) | SBUS 36 | 38.9 | 35.8 |
| Intermediate Semi-Trailer | WB 40 | 40.0 | 45.5 |
| Intermediate Semi-Trailer | WB 50 | 45.0 | 55.0 |
| Interstate Semi-Trailer | WB 62 | 45.0 | 68.5 |
| Interstate Semi-Trailer | WB 67 | 45.0 | 73.5 |

Notably, the more critical performance measure for heavy trucks for this assessment of the critical curves along Lime Creek Road is what is termed the “swept path width”, an illustration of which is shown in Figure 6.

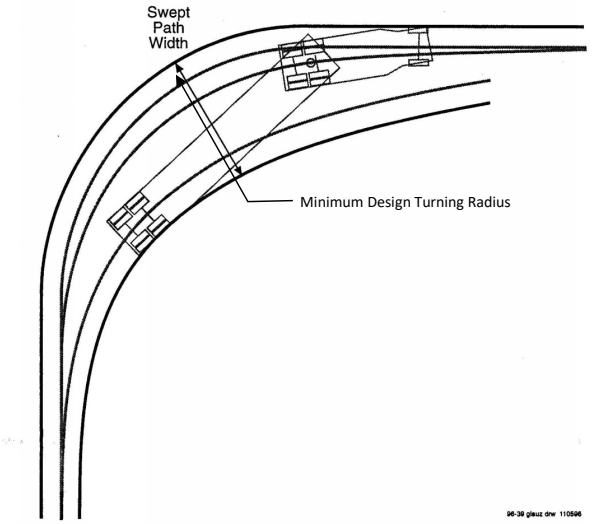


*Figure 6. Illustration of Swept Path Width (semi-trailer shown)*

To analyze the swept path width of heavy trucks that might be used during construction of the Pump Station and Maintenance Building, a software program called *AutoTurn*, version 10.2.1, was used to assess the constraints. An adaptive simulation was placed along the entire length of the studied roadway and critical curves highlighted that would need to be addressed.

Two of the more commonly utilized heavy truck sizes were assessed for their ability to negotiate the curvatures of the roadway: the WB-40 (wheel base 40 feet) and WB-50 (wheel base 50 feet) trucks at

a turning speed of 15 MPH as posted on existing signs in the corridor. A WB-40 truck is typically 8.0 feet wide and 45.5 feet long end-to-end and a WB- 50 truck is 8.5 feet wide and 55.0 feet long.

Table 5 shows the total angle of turn and the existing centerline of the northbound and southbound lanes for each of the curves. The combination of those two factors control the total area covered by the swept path of the heavy trucks. The table also shows the results of the *AutoTurn* analysis and the widening needed to contain the swept path within the travel lane.

*Table 5. Severe Curves versus Design Vehicle Turning Radius Information*

| Location | Posted Warning Speed | Angle of Turn | Centerline Radius of Paved Travel Lane Southbound / Northbound | Swept Path Overhang Southbound / Northbound |
|---|---|---|---|---|
| **CURVE 1** | 15 MPH | 130$^{O}$ | 110 | 3’/6.5’ |
| | | | 120 | 6’/9’ |
| **CURVE 2** | 15 MPH | 130$^{O}$ | 75 | 5’/10’ |
| | | | 85 | 5’/8’ |
| **CURVE 3** | 15 MPH | 153$^{O}$ | 70 | 4.5’/9.5’ |
| | | | 80 | 5.5’/9.5’ |
| **CURVE 4** | 15 MPH | 158$^{O}$ | 80 | 4.5’/9’ |
| | | | 90 | 4.5’/6.5’ |
| **CURVE 5** | 20 MPH | 134$^{O}$ | 100 | 4’/8.5’ |
| | | | 110 | 3.5’/7.5’ |

The northbound movements, being along the outside of the curves, track better within the northbound travel lane than for southbound traffic on the inside of the curves. The northbound lanes would need some pavement widening to allow the trucks larger than SB 30 to keep their swept path width within the travel lane. The southbound movements, being along the inside of the curve, would need slightly more pavement widening than the northbound to allow the heavy trucks to keep their swept path width within the travel lane. However, widening to the inside of the curves would involve significant bank stabilization.

The tight radius and the angle of turn of Curves 1, 2, 3, 4 and 5 create a condition that poses constraints on the size of trucks that can traverse Lime Creek Road. With special traffic control to halt opposing traffic at the curves, a long truck or oversized truck could utilize both travel lanes of pavement to traverse the roadway. Analysis using *Autoturn* finds that truck size WB 62, approximately 68.5 feet in length, would be the largest tractor-trailer truck that could traverse the unimproved Lime Creek Road using the full width of both lanes of pavement. There are special trucking apparatuses that can move longer pieces of equipment and building materials through tight curves using self-steering trailing axles.

### *4.3 Oversize Truck Deliveries*

During different phases of construction, there will be the need to bring in oversized equipment and lengthy building materials to and from the Project site. Anticipated oversize equipment, number of trucks and dimensions thereof are shown in Table 6.

*Table 6. Oversized Vehicle Requirements*

| Equipment | Length (ft) | Width (ft) | No. of Truck Trips | Road Requirements |
|---|---|---|---|---|
| Tunnel Boring Machine | 30 | 12 | 10-15 | Road shutdown due to width |
| Tunnel Rail | 25 | N/A | 5 to 10 | Traffic control at turns |
| Well Shaft Casings | 20 - 40 | 2.5 | 20 to 40 | Traffic control at turns |
| Steel Pipe | 20-40 | 7 | 60-120 | Traffic control at turns |
| HVAC Equipment | 30 | 11 | 5 | Road shutdown due to width |
| Bridge Crane Beam | 86 | 12 | 1 | Road shutdown due to width Special trailer required |
| Pumps | 32 | 2.5 | 5 | Traffic control at turns |
| Surge Tank | 45 | 16 | 1 | Road shutdown due to width and length Special trailer required |
| Transformer | 13 | 12 | 1 | Road shutdown due to width |
| Chemical Bulk Tanks to Maint. Bldg. – Sodium Hypochlorite Tank | 12 | 13 | 1 | Road shutdown due to width |
| Chemical Bulk Tanks to Maint. Bldg. – Copper Sulfate Tank | 10 | 11 | 1 | Road shutdown due to width |

Notes:

1. While this table includes information for the known equipment requiring an oversized vehicle, it should not be considered as the only requirements for oversized vehicles. Other equipment or materials not mentioned in this report may require oversized vehicles.
2. Contractor shall coordinate with Travis County regarding taller equipment requiring overhead utility adjustment/ clearance.

It is anticipated that there will be approximately 60-80 oversize deliveries requiring specialized trailering and a shut-down of the entire roadway for a period-of-time because of the width or length of the equipment being delivered. In these cases, as part of the construction requirements, the Contractor will be required to coordinate directly with Travis County for acceptable shut down times, alternative routes, and other acceptable options for mitigation.

### *4.4 Truck Route Mitigation Options*

Options to accommodate truck haul route movements during construction are described below.

#### 4.4.1 Option 1 - Widening Pavement at Critical Curves

As shown in Table 5, it was determined that between 3- and 10-feet of additional pavement would be required on each side of the existing pavement to allow a WB 40 and larger trucks to traverse the critical curves without encroaching into the other lane. After an initial evaluation of each curve, it was determined that expansion of the existing roadway at these turns is not practically feasible based on the following:

- Inside turns - significant retaining walls and shoring would be required due to the steep slopes. Limited working room inside right-of-way to make improvements without potential impact to Lime Creek Road traffic and/or nearby preserve property.
- Outside turns – Limited room from edge of pavement to edge of right-of-way. Would require retaining walls and major modifications to the existing drainage structures with very little room to make improvements.

- Removal of trees and vegetation would be required on both the inside and outside curves, potentially impacting adjacent preserve property and/or habitat.

#### 4.4.2 Option 2 - No Mitigation – Use Trucks That Fit in Existing Roadway

Mitigation Option 2 includes using SU 30 or smaller dump trucks for hauling of spoils from the site to minimize roadway traffic closures. Without any improvements to Lime Creek Road or traffic control, construction vehicles would be limited to SU 30 or smaller trucks to stay in one lane. Using these smaller trucks (as opposed to a WB 50 truck) would approximately double the daily truck traffic used for removal of spoil materials. For this option, delivery of materials and equipment over approximately 20 feet in length would still require larger trucks and associated traffic control.

#### 4.4.3 Option 3 - Utilize larger (WB 50) trucks with short-term lane closures and traffic control

Mitigation Option 3 would allow hauling of spoils using tractor trailer trucks up to WB 62 in length to minimize the number of trucks hauling along Lime Creek Road. The use of longer single unit trucks and trailer trucks greater in length than SU 30 would require extending into the opposing lane to negotiate the five critical curves identified herein. This in turn would require the use of pilot trucks or other means of traffic control to halt opposing vehicles in advance of the critical segments so that the trucks can safely use the width of both lanes of pavement to accommodate their swept path. Based on the initial review, it is anticipated that a WB 62 is adequate to handle most of the construction activities, with the exception of oversize deliveries which will require special trailering and traffic control strategies with any option.

### *4.5 Access Options to Maintenance Building*

The construction of the Maintenance Building will require some type of connection to Bernard Street. Two options considered for this connection: either access along Sherman Street via a stub out from Bernard Street or full connectivity of Jackson Street with Bernard Street. The design assumptions and considerations for the two options are summarized below as well as proposed cost estimates for each option.

#### 4.5.1 Connection Design Considerations

The Maintenance Building will be situated near the existing cul-de-sac at Bernard Street. Currently there is no roadway to transport vehicles or materials to the project site. Figure 7 shows the overall locations of the Maintenance Building and the Jackson Street Extension.


*Figure 7. Jackson Street Extension at Maintenance Building*

4.5.2 Site Connection Option #1 – Use of Sherman Street via a Stub out Extension of Bernard Street

The first option to connect the Bernard Street with the Maintenance Building would be to construct a stub out roadway from the existing cul-de-sac end of Bernard Street. This option presents the least amount of roadway construction. However, this option will still contain retaining walls and drainage features on a smaller scale and creates a dead end at the Maintenance Building. This option is shown below in Figure 8. The potential construction cost for this option (using the City of Austin and TxDOT Low Bid Unit Prices) is approximately $434,163.60 and summarized in Table 7.

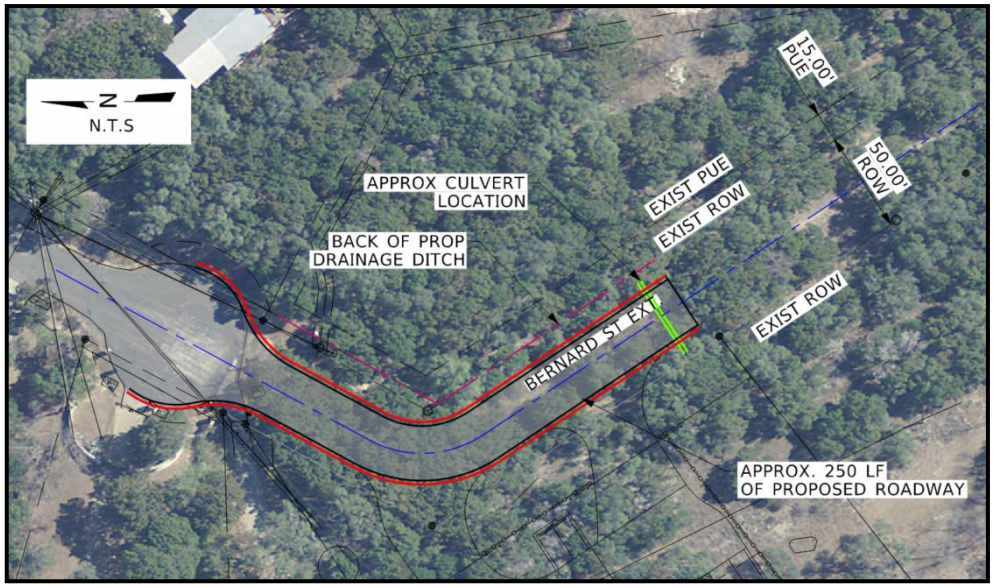


*Figure 8. Maintenance Building Access Option #1: Bernard Street Stub-out*

*Table 7. Construction Cost Estimate - Option 1*

| ITEM | UNIT | UNIT COST | QTY | COST |
|---|---|---|---|---|
| **ROADWAY PAVEMENT SECTION** Asphalt, Earthwork, Curb & Gutter | LF | $608.27 | $350.00 | $212,896.00 |
| **ROADWAY MISC.** Prep ROW, Riprap, guard fence | LF | $92.25 | $350.00 | $32,288.00 |
| **RETAINING WALL** Wall, Concrete Rail, Handrail | LF | $99.09 | $350.00 | $34,680.00 |
| **DRAINAGE** Inlets, Riprap, End Treatments | LF | $48.57 | $350.00 | $17,000.00 |
| | | **TOTAL** | | **$296,864.00** |
| | | Mobilization (7%) | | $20,780.48 |
| | | Signing and Striping (5%) | | $14,843.20 |
| | | SW3P (5%) | | $14,843.20 |
| | | **TOTAL + CONTINGENCY (25%)** | | **$434,163.60** |

4.5.3 Site Connection Option #2 – Extension of Jackson Street to Bernard Street

The second option to connect Bernard Street with the Maintenance Building would be to extend Jackson Street from Terrel Street to Bernard Street, as shown in Figure 9. This option will require offsite and on-site drainage systems as well as a retaining wall along the Jackson Street Extension. Water quality will be treated on the Maintenance building site.

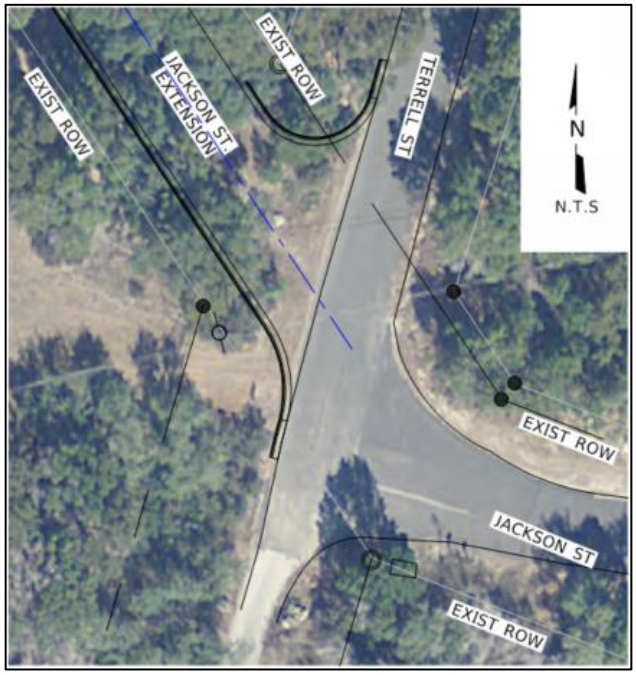


*Figure 9. Skewed Intersection of Jackson Street Extension for Maintenance Building Access Option #2*

The angle of the Jackson Street ROW at the end of the road does not line up directly at the intersection with Jackson Street, as shown in Figure 10. The offset intersection should be realigned to create a skewed but aligned intersection. The existing Jackson Street centerline includes a 200' radius curve and intersects Terrel Street at a right angle. This option, as shown in Figure 10, would tighten the horizontal curve to 100' and meet Terrell Street at a skewed angle to line up across with Jackson Street. As shown in this exhibit, the re-alignment of Jackson Street would require minimal changes to the existing configuration.

The potential construction cost for this option (using the City of Austin and TxDOT Low Bid Unit Prices) is approximately $1,045,384.10 and summarized in Table 8.

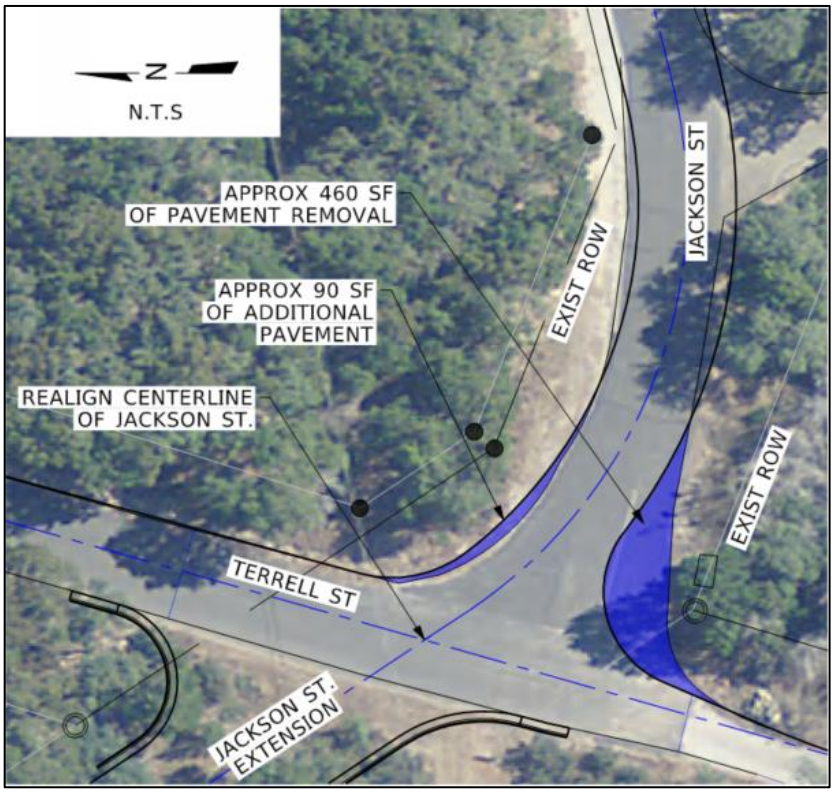


*Figure 10. Option #2 Improvements to Jackson Street at Terrell Street to line up with the Jackson Street Extension*

*Table 8. Option 2 Cost Estimate*

| | UNIT | UNIT COST | QTY | COST |
|---|---|---|---|---|
| **ROADWAY PAVEMENT SECTION** Asphalt, Earthwork, Curb & Gutter | LF | $350.20 | 650 | $227,632.55 |
| **ROADWAY MISC.** Prep ROW, Riprap, guard fence | LF | $57.02 | 650 | $37,065.00 |
| **RETAINING WALL** Wall, Concrete Rail, Handrail | LF | $587.76 | 650 | $382,045.00 |
| **DRAINAGE** Inlets, Riprap,End Treatments | LF | 104.69 | 650 | $68,050.00 |
| | | **TOTAL** | | **$714,792.55** |
| | | Mobilization (7%) | | $50,035.48 |
| | | Signing and Striping (5%) | | $35,739.63 |
| | | SW3P (5%) | | $35,739.63 |
| | | **TOTAL + CONTINGENCY (25%)** | | **$1,045,384.10** |

### 4.5.4 Comparison of Maintenance Building Site Connection Options

Ultimately, portions of Jackson Street or Bernard Street will have to be extended to accommodate the new Maintenance Building. Table 9 compares the pros and cons of constructing the full Jackson Street extension versus a temporary access or Bernard Street stub out.

*Table 9. Comparison of Design Options*

| Pros to Building the Full Jackson Street Extension | Cons to Building the Full Jackson Street Extension |
|---|---|
| ROW is currently acquired. | Intersection at Jackson St. will need to be realigned to eliminate the jog between the Jackson Street Extension and Jackson Street addressing the poor geometry. |
| Provides residential development opportunities along the new roadway. | Does not provide additional mobility to residents. |
| Improved access to Maintenance Building | Additional Costs: Grading, Retaining Walls, Drainage, potential Water Quality. |
| Sight distance is better at Lime Creek and Jackson St. | Road will be aesthetically different from the other roads in the area. (Curb and gutter, retaining wall) |
| Provides a through traffic option for access to Maintenance Building. | |
| Intersection of Sherman @ Bernard may not need to be improved. | |
| Provides residents another alternative for exiting the neighborhood. | |
| Provides emergency services an option to pull through rather than turning around. | |

Given these considerations, the Jackson Street approach to the Maintenance Building would be preferred over the Sherman Street approach.

## 5.0 TRAFFIC VOLUMES

Traffic counts were taken during a typical weekday in the summer, on Wednesday, July 17, 2019. The count locations are shown in Figure 11 and consist of 24-hour classification counts at five locations along Lime Creek Road and peak period turning movement counts at the intersections of Lime Creek Road and Anderson Mill Road and FM 2769 and Anderson Mill Road.


*Figure 11. Traffic Data Collection along Lime Creek Road*

*5.1 Traffic Counts and Vehicle Classification Data*

Traffic count and vehicle classification data were taken at the five numbered locations shown in Figure 11. The data are summarized in Table 10 and are discussed below.

*Table 10. Tabulation of Current Directional Traffic Count and Classification Data*

| Map ID | Southbound | | | Northbound | | | Total Both Directions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AM Peak Hour | PM Peak Hour | 24-hour Volume | AM Peak Hour | PM Peak Hour | 24-hour Volume | AM Peak Hour | PM Peak Hour | 24-hour Volume | % Trucks | |
| | | | | | | | | | | Hvy. | Med. |
| 1 | 33 | 36 | 382 | 27 | 31 | 336 | 60 | 67 | 718 | 2.0 | 0.5 |
| 2 | 33 | 31 | 327 | 31 | 31 | 333 | 64 | 62 | 660 | 2.0 | 0.5 |
| 3 | 21 | 42 | 379 | 34 | 29 | 392 | 55 | 71 | 771 | 0.8 | 0.7 |
| 4 | 117 | 121 | 1,209 | 72 | 135 | 1,177 | 199 | 256 | 2,386 | 0.4 | 0.2 |
| 5 | 190 | 745 | 4,582 | 531 | 278 | 3,885 | 721 | 1,043 | 8,467 | 1.6 | 0.2 |

5.1.1 Daily Traffic and Peak Hour Directional Movements

By comparison, the northern segment of Lime Creek Road (count locations #1, 2 and 3 northwest of the center of the Village of Volente) is much less traveled than the southern segment (count locations #4 and 5 northeast of the center of the Village of Volente), described in more detail below:

- Northern Segment of Lime Creek Road: At less than 400 vehicles per day, this segment of Lime Creek Road is sparsely used. During the peak hours of the day, only one car every two minutes goes northbound and southbound.
- Southern Segment of Lime Creek Road and FM 2769: There is a notable increase in daily traffic between count locations # 4 and 5 on FM 2769, due mostly to traffic contributions to and from Bullick Hollow Road, which provides a connection between FM 2769 and FM 620. Bullick Hollow Road is also the accessway to get to the lakefront developments of Comanche Canyon Ranch, Comanche Trail and Comanche Village. The counted 8,467 vehicles per day is nearing the capacity of this easternmost segment of the two-lane roadway.

5.1.2 Heavy Truck Traffic Counts

Usage of Lime Creek Road by heavy trucks ranges from 0.4 to 2.0 percent of the total traffic flow, as shown in Table 10. At the northern end, Count Stations #1 and 2, there were only 7 heavy trucks inbound and 7 outbound during the day to comprise the 2.0 percent of a relatively low daily traffic flow. At Count Station #5, the 1.6% heavy trucks of the 8,467 vehicles per day total daily traffic flow represents 57 heavy trucks northbound and 80 heavy trucks southbound during the day. That segment of FM 2769, between Bullick Hollow Road and Anderson Mill Road, appears to currently be a relatively heavily utilized segment for both cars and trucks.

*5.2 Peak Hour Turning Movement Counts at Existing Signalized Intersections*

At the two intersections of Lime Creek Road with Anderson Mill Road, there are existing traffic signals with dedicated left turn lanes on all approaches. The intersection operations appear to currently provide a good level of service with capacity to accommodate additional traffic volumes.

### 5.2.1 Lime Creek Road at Anderson Mill Road (North)

The turning movement counts at this intersection at the north end of Lime Creek Road are presented in Table 11. The traffic data shows the directionality of flow on Anderson Mill Road – heavier eastbound (inbound to Austin) in the AM peak hour and the reverse in the PM peak hour. The westbound turn volumes, from Anderson Mill Road to Lime Creek Road, are relatively low; the higher volume, 36 vehicles per hour, are opposed by the off-peak direction of travel on Anderson Mill Road. The intersection appears to have ample capacity to receive the anticipated construction traffic of trucks and employee vehicles.

*Table 11. Peak Hour Turning Movement Counts for Lime Creek Road at Anderson Mill Road (North Intersection)*

| Peak Hour | Eastbound Anderson Mill | | | Westbound Anderson Mill | | | Northbound Lime Creek | | |
|---|---|---|---|---|---|---|---|---|---|
| | Right | Thru | Left | Right | Thru | Left | Right | Thru | Left |
| AM | 8 | 741 | 0 | 0 | 272 | 13 | 21 | 0 | 27 |
| PM | 21 | 469 | 0 | 0 | 729 | 36 | 20 | 0 | 20 |

An operational analysis was performed for this northern intersection of Lime Creek Road at Anderson Mill Road using *Synchro*, a traffic simulation and signal optimization computer model. The analysis found that both the AM peak and PM peak hour operations, under existing traffic conditions, operate with very little average delay (approximately 8 seconds per vehicle, correlating to Level of Service (LOS) A on an A through F scale). There also appears to be significant available capacity for future traffic growth. A sensitivity analysis using Synchro indicated that the intersection volumes could grow by 200% and the intersection would still operate at LOS C (moderately good) during the PM peak hour.

### 5.2.2 FM 2769 at Anderson Mill Road (South)

The turning movement counts at this intersection at the north end of Lime Creek Road are presented in Table 12. The traffic data shows the directionality of flow on Anderson Mill Road – heavier eastbound (inbound to Austin) in the AM peak hour and the reverse in the PM peak hour. The westbound turn volumes, from Anderson Mill Road to Lime Creek Road, are relatively high; the higher volume, 202 vehicles per hour, are opposed by the off-peak direction of travel on Anderson Mill Road. The intersection appears to have some capacity to receive the anticipated construction traffic of trucks and employee vehicles, but the westbound left turn from Anderson Mill Road to Lime Creek Road appears to operate at near capacity. A sensitivity analysis using Synchro indicated that the intersection volumes could grow by 80% and the intersection would still operate at LOS C during the PM peak hour, with proper reallocation of signal green time to critical approach movements as needed during the duration of construction. Signal optimization would require minimal effort including coordination with Travis County.

*Table 12. Peak Hour Turning Movement Counts for FM 2769 at Anderson Mill Road (South Intersection)*

| Peak | Eastbound Anderson Mill | | | Westbound Anderson Mill | | | Northbound Lime Creek | | |
|---|---|---|---|---|---|---|---|---|---|
| | Right | Thru | Left | Right | Thru | Left | Right | Thru | Left |
| AM | 39 | 993 | 0 | 0 | 287 | 99 | 160 | 0 | 12 |
| PM | 24 | 512 | 0 | 0 | 804 | 202 | 169 | 0 | 169 |

An operational analysis was performed using *Synchro*, which found both the AM peak and PM peak hour operations, under existing traffic operations, to operate with very little average delay (approximately 10 seconds per vehicle, correlating to Level of Service B on an A through F scale) and appears to have available capacity for traffic growth. Green time from other approaches can be reallocated to the heavier movements as needed, such as for the westbound left turn.

### *5.3 Projected Traffic Volumes and Operations*

Daily and peak hour traffic from construction of the Pump Station and the Maintenance Building will add traffic onto Lime Creek Road and the intersections with Anderson Mill Road. The expected peak hour and daily volumes are shown in Table 13.

*Table 13. Construction Trip Generation, Estimated Typical Daily Traffic*

| Trip Generator | AM Peak Hour Trips | | PM Peak Hour Trips | |
|---|---|---|---|---|
| | **Inbound** | **Outbound** | **Inbound** | **Outbound** |
| **Pump Station** | | | | |
| Heavy & Medium Trucks | 10 | 10 | 10 | 10 |
| Worker's Vehicles | 50 | 0 | 0 | 50 |
| **Total Pump Station** | **60** | **10** | **10** | **60** |
| **Maintenance Building** | | | | |
| Heavy & Medium Trucks | 2 | 2 | 2 | 2 |
| Worker's Vehicles | 10 | 0 | 0 | 10 |
| **Total Maint. Bldg.** | **12** | **2** | **2** | **12** |

#### 5.3.1 Lime Creek Road at Anderson Mill Road (North)

For the *Synchro* analysis, construction-generated traffic was added to the existing (background) traffic. It was assumed that all added construction traffic for the Pump Station, both trucks and worker's vehicles, were directed to approach the Pump Station site from the north. For the Pump Station, all inbound construction worker vehicles were assumed to use the left turn lane on northwest bound Anderson Mill Road to access Lime Creek Road and do the reverse for outbound. Outbound heavy trucks were assumed to turn left from Lime Creek Road onto northwest bound Anderson Mill Road and do the reverse for the inbound. Adding these trips to the background existing traffic and optimizing to balance the green time allocations, the Levels of Service obtained in the Synchro analysis for the existing traffic remained unchanged, with average delay increasing by less than 2 seconds per vehicle.

#### 5.3.2 FM 2769 at Anderson Mill Road (South)

For the *Synchro* analysis, construction-generated traffic was added to the existing (background) traffic. It was assumed that all added construction traffic for the Maintenance Building, both trucks and worker's vehicles, were directed to approach the Maintenance Building site from the south. For the Maintenance Building, all inbound construction worker vehicles were assumed to use the left turn lane on northwest bound Anderson Mill Road to access Lime Creek Road and do the reverse for outbound. Outbound heavy trucks were assumed to turn left from Lime Creek Road onto northwest bound Anderson Mill Road and do the reverse for the inbound. Adding these trips to the background existing traffic and optimizing to balance the green time allocations, the Levels of Service obtained in

the Synchro analysis for the existing traffic remained unchanged, with average delay increasing by less than 1 second per vehicle.

## 6.0 DAILY WORKER TRAFFIC AND PARKING

The potential on-site parking locations for construction staff include the Pump Station site itself and a one-acre temporary construction easement north of the Pump Station site in Sandy Creek Park, as shown on Figure 12. Due to anticipated space constraints on the Pump Station construction site, the high probability that the Contractor will need to utilize the one-acre TCE for equipment and materials and the restriction from Travis County for roadside parking in the Lime Creek Road right-of-way, it is most likely that construction workers would need to be shuttled into the site from a remote parking location. One very practical remote parking area that could be considered is at Sandy Creek Park, immediately adjacent to the Pump Station site, as shown in Figure 12

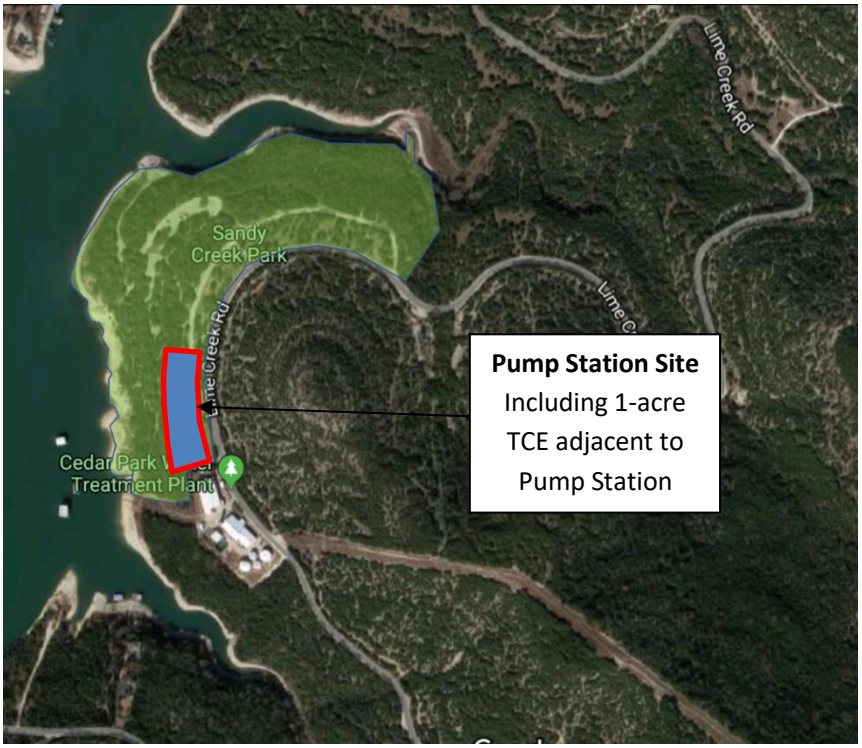


*Figure 12. Potential Remote Parking at Adjacent Sandy Lake Park*

If Travis County allowed a portion of the site outside the existing temporary construction easement to be used for construction parking, it would be possible to have workers walk to the Pump Station site from the offsite parking at Sandy Lake Park. The number of workers on the site at any time is dependent on the contractor's methods, but for planning purposes it is estimated that 50 employees would be working at the site as a normal high-activity point in the construction project.

It would be feasible to allocate a portion of the southern section of the 92-acre park for temporary use by the construction contractor for employee parking, but approvals would have to be obtained from Travis County. The park provides only primitive camp sites but allows for 24-hour camping and boat ramp usage. Sandy Creek Park is owned and maintained by Travis County, so some exploratory

discussions should be held with the Travis County Parks Department regarding the possibilities of such use. Possible consideration of other temporary contractor uses may be discussed to include field office, portable restrooms and potentially secure storage of small equipment. Contractor employees could alternatively be shuttled here from a location on Anderson Mill Road to lessen the impacts of employee parking on the landscape in the park. No construction parking will be allowed at the adjacent water treatment plant.

## 7.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

The following is a summary of the key observations and recommendations of this traffic study of the construction traffic impacts on the roadway operations along Lime Creek Road and on Jackson Street.

### *7.1 Size Constraints for Construction Vehicles and Mitigation Options*

Construction of the Pump Station will require significant truck traffic to and from the site for delivery of typical equipment, spoils and building materials. WB 50 trucks, approximately 55-feet in length, are typically used in delivery of these types of construction materials. Analysis using *Autoturn* shows that WB 50 trucks can traverse Lime Creek Road but will require both lanes of the roadway for Curves 1, 2, 3, 4 and 5. Three options were evaluated to mitigate construction traffic impact to Lime Creek Road including:

Option 1 - Expanding the roadway at Curves 1 through 5

Option 2 - Utilizing smaller (WB 30) trucks that can stay in one lane

Option 3 - Utilize larger (WB 50) trucks with short-term lane closures and traffic control.

After initial evaluation of these options, it was determined that Option 1 is not practically feasible. Therefore, it is recommended the Contractor be allowed to utilize Option 2 or 3, depending on materials being delivered, phase of the project and availability of construction vehicles.

### *7.2 Oversize Delivery Requirements*

In addition to normal construction deliveries, there will be approximately 15 to 20 deliveries that require trucks larger than WB 50. Initial evaluation of these deliveries indicate that it is feasible that this larger equipment and materials can be delivered but it will require shut down of the entire roadway and/or special trailering. In these cases, as part of the construction requirements, the Contractor will be required to coordinate directly with Travis County for acceptable shut down times, alternative routes, and other acceptable options for mitigation.

To facilitate the regular daily truck activities serving the construction sites, it is recommended that the construction contract documents require development of a detailed Traffic Control and Road Closure Plan and approval by the governing jurisdiction (Travis County and/or Volente) prior to construction.

*7.3 Traffic Volume Impacts*

There is ample capacity at the northern intersection with Anderson Mill Road/ Lime Creek Road and at the southern intersection of FM 2769/ Anderson Mill Road to accommodate the anticipated construction traffic from both the Pump Station and Maintenance Building sites. Depending on the size of truck that the Contractor elects to use, traffic control for daily short-term lane closures will be required. Heavy trucks hauling spoils from the Pump Station will be using low gears to climb the slope of Lime Creek Road up to Anderson Mill Road. As the traffic volumes on Lime Creek Road north of the Pump Station are comparatively low, the truck route for the Pump Station should be along Lime Creek Road to the north to minimize traffic delays. The truck traffic servicing the Maintenance Building would be acceptable to use either the route to the north or to the south, subject to approval of the contractor's Traffic Plan by the Village of Volente.

*7.4 Maintenance Building Access*

Utilization of Jackson Street for construction traffic to the Maintenance Building would be preferred over Sherman Street. Thus, the extension of Jackson Street from Terrel Street to the cul-de-sac on Bernard Street is recommended.

*7.5 Advance Considerations for Construction Employee Parking*

There is limited parking at the Pump Station construction site itself but there is space for some parking at the adjacent southern end of Sandy Creek Park. It is recommended to initiate discussions with the Travis County to explore the possibility of using a portion of Sandy Creek Park for Construction Employee Parking and/or other possible Contractor storage space needs.